THE UNIVERSITY OF ALBERTA

THE EFFECT OF INDUSTRIAL ARTS ON SCIENCE ACHIEVEMENT

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled, "The Effect of Industrial Arts on Science Achievement," submitted by Donald Winsor Manuel in partial fulfillment of the requirements for the degree of Master of Education.

ABSTRACT

The general problem of this study was to identify the existence of structure in industrial arts education. The study tested the objective: "to provide an environment where students can reinforce and apply the academic disciplines", focusing on reinforcement of grade nine science achievement.

The subjects of the study were a treatment group (N = 21), and a non-treatment group (N = 19), of grade nine girls participating in a treatment curriculum (the University of Alberta's Industrial Arts program), and a non-treatment curriculum (a Home Economics program).

Achievement (reinforcement) in science was measured in terms of the grade nine science departmental examination of the Department of Education, Government of Alberta. Responses of the two groups on the items of the science examination were analysed in groups representative of the Cognitive Domain of Bloom's Taxonomy. An analysis of covariance was used to determine the presence of significant difference between the responses of the treatment group and the non-treatment group; and a one-way analysis of variance was used to determine whether or not the treatment group responded 'unexpectedly' (in relation to a provincial sample of 3.6% of the grade nine students) higher on items representative of the higher levels of the Cognitive Domain than on items representative of the

"knowledge" level of the Cognitive Domain.

The treatment group was found to be significantly better than the non-treatment group in responding to items representative of the highest three levels of the Cognitive Domain. In addition the treatment group was somewhat more proficient than the provincial sample in responding to items representative of the three highest levels of the Cognitive Domain.

The complementary relationship between the "reinforcement" objective and the objectives of science education at the grade nine level tends to suggest that the program of Industrial Arts Education of the University of Alberta may in fact have <u>a structure</u>.

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CHAPTER I

INTRODUCTION

> Talk of the 'new' mathematics, the 'new' physics, and the 'new' biology is commonplace today. Various groups and individuals, handsomely supported by the National Science Foundation -- and, to a lesser degree, by several private philanthropic foundations -- have developed new courses and instructional materials to go with them for high school mathematics, physics, chemistry, biology, economics, geography, anthropology, English, and Foreign languages, and for several subjects taught in elementary schools. Thousands of teachers and students have participated in the preparation and trial use of these materials. Clearly, a massive reformulation of what is to be taught and learned in the schools of the United States of America is under way.

Industrial arts education is no exception to the reformulation activity referred to above by Goodlad (1964, p. 9). There are many new and emerging programs of industrial education.

The Canadian scene has also exhibited an activity of reformulation. The Federal Technical and Vocational Training Assistance Act of 1960 gave impetus and incentive to the development of technical and vocational education. This resulted in the need for industrial arts education to identify a clear role in general education, and to develop a structure consistent with this role.

A review of contemporary programs in industrial arts education in North America revealed a variety of approaches to the

solution of a basic problem -- identifying the structure of the subject matter in industrial arts education.

I. THE PROBLEM

General Problem

The general problem of this study was to identify the existence of structure in industrial arts education.

The structure of a discipline was seen to have two major segments. One segment dealt with the internal structure of the discipline; the other segment dealt with external structure of the discipline. Internal structure consists of the relationships that exist between the objectives within a discipline; external structure consists of the relationships that exist between the objectives of different disciplines.

This study was concerned with the discipline of industrial arts and the structure of the University of Alberta's Industrial Arts program.

Ziel, LeBlanc and Manuel (1966, p. 8) stated the objectives of the University of Alberta's Industrial Arts program.

1. To provide an environment where students can reinforce and apply the academic disciplines.
2. To provide exploratory experiences in the various productive aspects of society.
3. To provide a synthesizing educational environment.
4. To provide an introduction to the multiplicity of career opportunities.

Specific Problem

This study was concerned with the external segment of structure; specifically, with the effect, if any, that an experimental industrial arts curriculum had upon a learner's achievement in grade nine science (reference to objective number 1 above).

Assumption

The assumption was made that reinforcement of grade nine science curriculum, by the offering of the experimental curriculum, could be identified best if the emphasis of the examination media was identified. Based on a report by the High School Entrance Examination Board (1965, p. 8), Department of Education, Government of Alberta, the content of the grade nine science which was examined was delineated both in content area and in terms of objectives. The delineation of objectives was based on the organization pattern commonly known as Bloom's Taxonomy, Cognitive Domain. The organization pattern utilized by the Department of Education (1965, p. 8) is shown in Table I.

II. EXPERIMENTAL HYPOTHESES

The following hypotheses were tested in this study:

(1) the treatment group would have a higher mean score than the non-treatment group in the grade nine science departmental examination.

TABLE I

ORGANIZATION OF A GRADE NINE SCIENCE DEPARTMENTAL EXAMINATION

OBJECTIVES	TOPIC or CONTENT AREA									EMPHASIS
	Matter & Energy, Force, Work & Power	Mechanics		Chemical Reactions	Heat	Light	Transportation	Measurement	Science as Inquiry	
		Machines	Fluids							
1. KNOWLEDGE										40%
2. COMPREHENSION										30%
3. APPLICATION										20%
4., 5., and 6. ANALYSIS, SYNTHESIS AND EVALUATION										10%
EMPHASIS	5%	15%	5%	15%	15%	15%	10%	5%	15%	100%

*(2) the treatment group would achieve the same as the non-treatment group on items assigned to the "knowledge" objective.

*(3) the treatment group would have a higher mean score than the non-treatment group on items assigned to the "comprehension" objective.

*(4) the treatment group would have a higher mean score than the non-treatment group on items assigned to the "application" objective.

*(5) the treatment group would have a higher mean score than the non-treatment group on items assigned to the "analysis, synthesis and evaluation" objectives.

*(6) the treatment group would have a higher mean score than the non-treatment group on items within the content areas of "mechanics", "transportation" and "matter and energy, force, work and power".

*(7) the treatment group would have an unexpectedly higher mean score on items assigned to "comprehension" than those items assigned to "knowledge", where 'unexpectedly' is taken as being relative to provincial norms.

*(8) the treatment group would have an unexpectedly higher mean score on items assigned to "application" than those items assigned to "knowledge", where 'unexpectedly' is taken as being

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* Refer to the table on page 4.

relative to provincial norms.

*(9) the treatment group would have an unexpectedly higher mean score on items assigned to "analysis, synthesis and evaluation" than those items assigned to "knowledge", where 'unexpectedly' is taken as being relative to provincial norms.

III. THE NEED FOR THE STUDY

It was suggested (and supported by Ralph Tyler and Hilda Taba) that the examination of objectives was one useful technique of study to determine the existence of a structure of a discipline. Inlow (1966, p. 15) and Taylor (1966, pp. 23 - 24) agreed with this suggestion. Support for the above suggestion was observed upon examination of Ralph Tyler's writings. He stated (1950, p. 3):

> Many educational programs do not have clearly defined purposes. In some cases one may ask a teacher of science, of English, of social studies, or of some other subject what objectives are being aimed at and get no satisfactory reply. The teacher may say in effect that he aims to develop a well-educated person and that he is teaching English or social studies or some other subject because it is essential to a well-rounded education. No doubt some excellent educational work is being done by artistic teachers who do not have a clear conception of goals but do have an intuitive sense of what is good teaching, what materials are significant, what topics are worth dealing with and how to present materials and develop topics effectively with students. Nevertheless, if an educational program is to be planned and if efforts for continued improvement are to be made, it is very necessary to have some conception of the goals that are being aimed at. These educational objectives become the criteria by which materials are selected, content is outlined, instructional procedures are developed

> and tests and examinations prepared. All aspects of the educational program are really means to accomplish basic educational purposes. Hence, if we are to study an educational program systematically and intelligently we must first be sure as to the educational objectives aimed at.

Taba (1962, p. 197) stated:

> The chief function of the more specific platform of objectives is to guide the making of curriculum decisions on what to cover, what to emphasize, what content to select, and which learning experiences to stress. This level, in other words, contains the heart of the educational objectives in their usual sense, and clarification of the functions of objectives on this level is essential to arriving at a serviceable guide to curriculum development. Naturally these more specific objectives should be consistent with the general overarching ones and in their totality express the vision of the general aims.

If the theses of Taba and Tyler are accepted, then a study which attempted to identify the structure in a contemporary program might be of assistance to industrial arts educators.

The need of this study was related to the external segment of structure (as defined earlier), and specifically related to the general objectives of general education. The reinforcement of academic disciplines, by study in an Industrial Arts education program, is predicated upon the synthesizing nature of the structure. Bruner (1960, p. 7) expressed it this way.

> Grasping the structure of a subject is understanding it in a way that permits other things to be related to it meaningfully. To learn structure, in short, is to learn how things are related.

Phenix (1964, p. 319) agreed with the possibility and in fact the

desirability of such an educational offering.

> From the principle that the content of the curriculum shall come entirely from the disciplines, it is not to be concluded that the materials of instruction ought necessarily to be organized into separate courses each of which pertains to one of the disciplines. The discipline principle is not an argument, for example, for a departmentalized curriculum in the elementary school - or, for that matter, in the high school or college. It is possible to use knowledge from the disciplines in connection with studies that cut across several disciplines.

Bloom _et al_. (1965, p. 38) expressed a similar desirability.

> Although information or knowledge is recognized as an important outcome of education, very few teachers would be satisfied to regard this as the primary or sole outcome of instruction. What is needed is some evidence that the students can do something with their knowledge, that is, that they can apply the information to new situations and problems.

Further support for the need for the study was presented in a review of the literature (Chapter II).

IV. DEFINITION OF TERMS

The definition of terms appearing in such detail at this point was presented with the belief that understanding of what has been written to date was dependent upon the following definitions; _and_, that the reader would subsequently be relieved from the tedium of repetitive explanations in the pages to follow.

Treatment Curriculum

The 'treatment curriculum' was derived from the model for

Phase II industrial arts education proposed by the Department of Industrial Arts and Vocational Education, University of Alberta. The curriculum of this model, then, encompasses those objectives and subsequent content and learning sequences as interpreted for a research project of the above mentioned Department of the University of Alberta.

The content of the experimental treatment was an awareness level study, or introduction to seven technologies. These technologies were: computer, electronic, graphic communications, mechanical, power, power transmission, and testing. The interpretation of this 'awareness' level of knowledge was achieved by study beginning at a general level, and progressing to the more specific levels. Breadth of knowledge, rather than depth, was emphasized. 'Systems' which were representative of a given technology area constituted the general content; while 'units', 'components', and 'principles' of these systems, respectively constituted the more specific content.

The 'syntax' or environment of the experimental curriculum was significant to the learners' achievement of objectives. A multiple activity environment laboratory provided the opportunity for learning the interrelationships between the technologies.

The 'experimental curriculum' placed special emphasis upon "providing an environment where students can reinforce and apply the academic disciplines." Ziel (1963, p. 17) elaborated on this

by stating:

> Let us observe industrial arts always as a synthesizing educational process in a multiple activity environment. The argument for multiple activity is predicated upon the fact that no profession or occupational title operates in a vacuum. The interrelationships of functions, processes and technologies are very evident in society. As a synthesizing educational environment introduced at the seventh grade level it can help reinforce the purposes of academic disciplines.

Non-Treatment Curriculum

The 'non-treatment curriculum' was defined as the regular Home Economics IX offering as administered in Junior High Schools of the Edmonton Public School Board. A brief review of the Course of Studies and an interview with the teacher revealed the following description of this curriculum.

The general objectives of the non-treatment curriculum stated by the Subcommittee on Junior High School Home Economics (1961, pp. 1, 2) were:

A. Attitudes of:
1. Co-operation - involving whole-hearted participation in the daily duties of the home as well as in the social aspects of home life, thus developing high ideals of worthwhile and effectual family life.
2. Responsibility - marked by perseverence, personal honesty and willingness to accept the consequences of one's own actions.
3. Creativeness - in design and color, which will make the student's project distincly her own.
4. Scientific Exactitude - especially in the preparation of foods and in housekeeping methods - respect for knowledge and accurate information.
5. Social Concern - that will make the daily living

one of broad horizons and kindly gracious and appreciative association with all whom one comes in contact.

6. Reverence - marked by a conviction of a Deity, and regard for His supreme handiwork, mankind.

B. Understanding of:

1. The necessity for a clear knowledge of nutrition to ensure the wise planning of the family meals.
2. The value of a well-set table and correctly served meals for the social grace of eating.
3. The importance of using care in selecting fabrics and their appropriate use in the planning of wardrobes.
4. The importance of selection of suitable and becoming clothing within the budget.
5. The importance of establishing habits of cleanness and tidiness in the regular care of one's room.
6. Personal relationships with other members of the family and society in general.
7. The need for safety measures that should be practiced, especially in the home.

C. Basic Skills in:

1. The use and care of equipment required in the preparation of food and clothing and in the care of the home.
2. The selection, preparation and care of food, clothing and home furnishings.
3. Making simple stitches and seams and the use of the pattern in garment construction.
4. Handicrafts which may later develop into hobbies.
5. Simple home nursing routines.
6. Care and guidance of younger children.

The program content for grade nine home economics for students who have had only one previous year of home economics instruction was as follows:

Nutrition - to review and apply Canada's Food Guide and nutrition; minerals and calories; and to review meal planning.

Cookery - less tender cuts of meats; vegetables; salads; biscuits; pastry; and simple desserts.

Sewing - construction of a simple cotton dress or a project of equal difficulty.

Electives - vocational future; homemaking in other lands; and lives of famous Canadian women and their contribution.

The organization within the laboratory for the non-treatment curriculum was focused around project construction. Related information was introduced as the need was seen for assistance in project construction. A student progressed from simple projects to more complex projects and was encouraged to apply knowledge to new applications.

Treatment Group

Twenty-one grade nine girls from a Junior High School in the Edmonton Public School system constituted the treatment group. The girls were student participants in a research project of the Department of Industrial Arts and Vocational Education, and subsequently were students of the treatment curriculum.

Non-Treatment Group

Twenty-one grade nine girls (from the same school as the treatment group) constituted the non-treatment group. They were

selected as a control group for the above mentioned research project. The grade nine school offerings of the non-treatment group were similar to those of the treatment group with one exception - they were students of the non-treatment curriculum.

CHAPTER II

RELATED LITERATURE

The related literature which is reviewed here encompasses three areas. The first is related to the problem of discipline and structure; the second to existing contemporary industrial arts education programs; and the third to the assumption concerning the use of the classification of the science examination items into Bloom's cognitive classifications.

I. DISCIPLINE AND STRUCTURE

General education was defined as that portion of formal education in our school systems which was made available to all students. The curriculum in general education was considered a mosaic composed from a number of disciplines.

'Discipline' was used in this study to mean "knowledge organized for instruction," as Philip Phenix (1962, p. 1) defined it.

> My thesis, briefly, is that _all_ curriculum content should be drawn from the disciplines, or to put it another way, that _only_ knowledge contained in the disciplines is appropriate to the curriculum. Exposition of this position requires first that we consider what is meant by a "discipline". The word "discipline" is derived from the Latin word _discipulus_, which means a disciple, that is, originally, one who receives instruction from another. _Discipulus_ in turn stems from the verb _discern_, to learn. _Etymologically_, then a discipline may be construed as knowledge, the special property of which is its appropriateness for teaching and its availability for learning. A discipline is knowledge organized for instruction.

Industrial arts education, according to Phenix, would be a discipline concerned with providing all students unique knowledge organized for instruction. An examination of the discipline included a consideration of the structure of this discipline.

Gail Inlow, (1966, p. 15) made specific reference to discipline and structure.

> The proposition is that the inherent structure of any discipline is the only proper source of learning content; that the learner who demonstrates the structure of any discipline will be able to contend with any aspects of the discipline. This concept and the growing theory to support, say many, provide education with the answer to the knowledge explosion. Nurtured, if not conceived, in the mind of Jean Piaget, the concept became full blown when elaborated by, among others, Jerome Bruner, and Philip Phenix.
>
> Basic to the entire issue, of course, is the meaning that the respective theorists ascribe to the word structure. In searching for an answer, I often felt that the theorists, like the fabled six blind men of Indostan, were reacting to different parts of the academic elephant. Yet from the welter, the following specifics seemed to emerge.
>
> 1. Each discipline has its own structure.
> 2. Structure within each discipline consists of the fundamentals (and/or concepts, and/or powerful ideas) that are sequential and related.
> 3. Because mastery of copious detail is impossible and undesirable, details should be grouped into a structured pattern of concepts, formulas, and theory from which nonspecific as well as specific transfer may be made.
> 4. Each discipline has its own methods and tools of discovery -- sometimes discrete, sometimes shared with other disciplines.
> 5. Teaching and learning should follow the methods that brought the discipline into being in the first place, and act, on a continuing basis, to refine its conceptualizations.
> 6. A discipline is never to be converted into a teaching arrangement; it is the teaching arrangement. It is to be learned as the scholars learned it and developed it.

7. A study of, and in, the disciplines should constitute educational effort from the earliest elementary grades until general education terminates. And study at all levels should be organized around the central themes of each discipline. Bruner, for instance, cites these two concepts as germane for the primary grades: that all things are connected and that all things serve a function.

The position advanced by Inlow stressed the observation that the structure of a discipline is unique. In addition, it can be seen that a program of instruction or a curriculum would have as its content source and pedagogical organization the discipline to be taught. This suggest that any two reportedly different programs of instruction in physics, for example, would be definition be similar.

Point "5" of Inlow was interpreted to mean that new discoveries within the discipline would subsequently affect the programs of instruction based on this discipline.

Point "6" of Inlow, "It is to be learned as the scholars learned it and developed it," should not be taken to mean the process of learning by trial and error (as many times was the case with new discoveries in a discipline), but rather that the learner can progress by directed discovery in a manner similar in sequence to that of the scholars.

A clear definition of the term 'structure' was sought. P. A. Taylor (1966, pp. 23 - 24) differentiated between logical-formal and empirical structure.

It seems that 'structure' has been used in a number of ways, at least the three following meanings having some concurrent relevance:

1. The formal or logical structure of a discipline or a branch of a discipline. Efforts to establish the formal or logical foundations of a discipline often involve attempts to set up the informally given discipline as a formal theory or as an axiomatic or hypothetico-deductive system. (It was mostly in this sense that we referred to 'structure' in the last chapter). They may also involve attempts to study the relation of the discipline to the philosophy of science. Methodological, epistemological and philosophical structures are on occasion used as synonymous terms with one another and with formal or logical structures.
2. The term is also used with a referent analogous to a building, a construction. In this sense 'structure' refers to facts, knowledge, and techniques -- the 'parts' -- and their combinations and interrelations. The term may be used in a closely allied sense with reference to the interrelation of parts as dominated by the general character of the whole, as when we speak of 'the structure of society'.
3. The third sense in which the term 'structure' is used - and which is of least relevance here - is when the referent is the anatomical basis for behavior.

In addition, Taylor (Ibid., pp. 29 - 30) wrote:

> Finally, structure was taken to refer to both the parts of an object and to the interrelationships between them. The structure of a molecule would be its atomic constituents and the way the atoms are arranged. The structure of a curriculum would be the various subjects and educational activities and their arrangement: the educator's reference to scope and sequence of a curriculum illustrates structure as applied to curriculum considerations. As was pointed out, knowledge of the structure of an object relays little information about the relation of that particular object to other objects. Thorough knowledge of the structure of a certain molecule does not, of itself, provide knowledge of how that molecule will react with other molecules. The structural knowledge of chemistry is necessary before that is possible. In curricular terms, this implies that knowledge of the structure of biology, chemistry, history, and

> so on does not enable us to organize either knowledge or the curriculum. This is not to say that clarity regarding the structure of mathematics is unimportant, but that to a curriculum builder it is not sufficient for his task. From the standpoint of the curriculum, the disciplines can be viewed primarily as a resource that can be drawn upon for the education of students. The point was made that although many factors -- the needs and characteristics of students and society, and the way learning takes place -- must be considered in designing the curriculum, if curriculum development is to keep pace with demands upon it, each school subject, along with its associated disciplines, should be under constant surveillance. The disciplines need examination in terms of their structure. The school subjects need examination to determine whether recent findings in the disciplines are, or should be, reflected in the subject.

The significance of what Taylor says here is that interrelationships between 'parts' of a structure must be considered for curriculum development, and also that examination of school subjects must be performed <u>in addition</u> to the examination of the discipline from which the subject derives its content. This additional examination could be in the area of objectives of the school program. This was evident when Taylor showed his cognizance to "the needs and characteristics of students and society, and the way learning takes place."

II. CONTEMPORARY PROGRAMS

The writer accepted the position advanced by Inlow, and reviewed selected contemporary programs of industrial arts in an effort to determine the structure that was unique to the discipline

of industrial arts. The review which follows surveyed each contemporary program by attempting to identify common purposes, contents and techniques of application.

<u>Technology and Industrial Arts Program</u>

<u>Purpose</u>: Olson (1963, p. 165) expressed his program's objectives in terms of function. 'Function' included both objectives and purposes; inherent in them was a program of action.

<u>Content</u>: The functions were technical (competencies with materials, tools, machines, and products), occupational (an orientation as to how people make a living), consumer (to enlighten the student in his role as a consumer), recreational (development of avocational interests), cultural (providing historical, anthropological, and sociological information about technology), and social (helping the student to discover his 'self' in the technological society).

<u>Technique</u>: The 'project' was the means for learning the content for Olson's program, as well as the measure of the students' learning.

<u>Functions of Industry Program</u>

<u>Purpose</u>: The primary objective of this program stemmed from a concern for the vocational guidance of the individual. This concern was two-fold: the nature of the occupational choice, and the nature of the individual making this choice.

Content: The content for Bateson and Stern's program of industrial arts education also came from a representative sampling of the "functions of industry".

Technique: Bateson and Stern (1962, p. 7) related their program's technique of application as an inquiry achieved by exploratory experiences into the "functions of industry" (basically the production of goods and service of goods).

> Students who have had exploratory experience related to the functions of industry will be much better prepared to cope with the task of occupational choice.

University of Maryland Program

Purpose: According to Maley (1962, p. 271), this program attempted to:

> . . . provide an inter-disciplinary (economic, psychological, sociological, industry, and education) approach to the better understanding of industry and technology.

Content: The content for the program of industrial arts education developed at the Univerisity of Maryland, was drawn from a wide range of disciplinary fields. Maley (Ibid.) related the nature of the content when he stated that the source of content was:

> . . . an analysis of the society in which the program would function, an analysis of the psychological elements that were related to it, and an examination of the role of the school in providing programs of substance and worth.

Technique: Very little information as to techniques for application of learning the above content was found.

Conceptual Approach to American Industry Program

Purpose: The designers of this program stated that the objectives of industrial arts are to develop an understanding of those concepts that apply directly to industry, and to develop the ability to solve problems related to industry. Face, Flug and Swanson (1965, p. 65) defined concept as:

> . . . psychological construct resulting from a variety of experiences (detached from the many situations giving rise to it), fixed by a word or idea, and having functional value to the individual in his thinking and behavior.

Content: Content for the above program was stated to be industry. Face, Flug and Swanson (1965b, p. 16) defined industry as:

> . . . a complex of organizations that utilize the basic resources of man, materials, machines and money to produce goods or provide services to meet the needs of man.

Technique: The achievement of the objectives of this program was accomplished by industrially simulated laboratories, where students performed activities related to the concepts and problems of industry.

Ohio State Program

Purpose: The program of industrial arts education reviewed here was not developed much beyond a feasibility research project.

This research project had as its purpose, as defined by Towers, Lux and Ray (1967, p. 16):

> . . . rigorously define content; develop a package of teaching materials; field test, demonstrate and disseminate these materials; and organize teacher education programs.

Content: The content of their developing program ranged from the historical-industrial development of man (*Ibid.*, Attachment D, p. 2) to the categorization of the practices in changing the forms of materials (*Ibid.*, Attachment D, p. 101). This content was structured by way of a three dimensional matrix, containing progression directives from the general to the specific.

Technique: Procedures for teaching and learning the content of the industrial arts program developed by E. R. Towers and associates, were not then defined.

University of Alberta Program

Purpose: This program has as its specific and unique objectives (previously noted on page 2):

1. To provide an environment where students can reinforce and apply the academic disciplines.
2. To provide exploratory experiences in the various productive aspects of society.
3. To provide a synthesizing educational environment.
4. To provide an introduction to the multiplicity of career opportunities.

Content: Ziel, LeBlanc and Manuel (*Op. Cit.*, pp. 8 - 9)

state that the objectives are achieved by the following offering:

> Industrial Arts as it is conceived at the University of Alberta is a synthesizing educational process conducted in a multiple activity environment. The general concept is predicated upon the fact that no profession or occupation operates in a vacuum. The interrelationships of functions, processes and technologies are very evident in contemporary occupations. The program is designed to make an articulate contribution to secondary general education, and is envisioned as having four phases which would be pursued from grade VII through grade XII. As a synthesizing educational environment, Industrial Arts can reinforce the command of academic disciplines. The multiple activity environment introduces boys and girls to a variety of experiences designed to interpret the current Productive Society and provide a base to make a more intelligible vocational choice.

Technique: The above quotation includes statements of both content and technique directives.

Summary

The preceding review of contemporary programs attempted to identify purposes, contents and techniques of application of each of the respective programs. The fact that reasonable definitions of purpose, content and technique were found for each program, then, according to Phenix, made industrial arts a discipline. But, according to Inlow (where commonness is of prime significance) a definition of structure of industrial arts was absent. This, then, further supported the need for the study.

IV. THE COGNITIVE DOMAIN

The following was in support of the assumption concerning the emphasis and nature of the examination media (page 3). There were two reasons for making this assumption and selecting the taxonomy as the classification instrument.

The first reason was based on the fact that the High School Entrance Examination Board, Department of Education used this classification to design the examination. The Department of Education (1965, p. 1) defined the cognitive domain:

> The cognitive domain was defined to include all those objectives which deal with the recall or recognition of knowledge and the development of intellectual abilities and skills. Most of what children learn in reading and arithmetic, for example, and what high school students learn in science, mathematics, English and social studies are learnings in the cognitive domain - knowledge and intellectual skills and abilities.

The second reason for the selection of the cognitive domain was predicated on the belief that the treatment curriculum expressed its greatest reinforcement capabilities in areas of learning other than recall of knowledge. It was for this reason that an examination of the respective groups' (treatment and non-treatment) performance on the examination should be reviewed in a manner which indicated what classifications of learning were affected.

Some considerations about the taxonomy follow. It was important to note that the taxonomy is a hierarchy. Bloom _et al_.

(1956, p. 120) stated:

> The whole cognitive domain of the taxonomy is arranged in a hierarchy, that is, each classification within it demands the skills and abilities which are lower in the classification order.

The taxonomy provides for the classification of the intended behavior of students -- the ways in which individuals are to act, think or feel as the result of participating in some unit of instruction. It had to be recognized that the actual behavior of the students, after exposure to instruction, may differ in degree and kind from the intended behavior specified by the objectives. Bloom et al. (1956, p. 38) discussed the nature of the abilities and skills.

> Although information or knowledge is recognized as an important outcome of education, very few teachers would be satisfied to regard this as the primary or the sole outcome of instruction. What is needed is some evidence that the students can do something with their knowledge, that is, that they can apply the information to new situations and problems. It is also expected that students will acquire generalized techniques for dealing with new problems and new materials. Thus it is expected that when the student encounters a new problem or situation, he will select an appropriate technique for attacking it and will bring to bear the necessary information, both facts and principles. This has been labelled "critical thinking" by some, "reflective thinking" by Dewey and others, and "problem solving" by still others. In the taxonomy we have used the term "intellectual abilities and skills." The most general operational definition of these abilities and skills is that the individual can find appropriate information and techniques in his previous experience to bring to bear on new problems and situations. This requires some analysis or understanding of the new situation; it requires a background of knowledge or methods which can be readily utilized; and it also requires some facility in discerning the appropriate relations between previous experience and the new situation.

Appendix "A" contains a condensed version of the Taxonomy of Educational Objectives; Cognitive Domain as summarized by Bloom _et al_. (1956 (appendix) pp. 201 - 207).

V. SUMMARY

The writer conducted a review of related literature in three main areas: 1) discipline and structure, 2) contemporary programs, and 3) the cognitive domain.

Discipline and structure were defined for purposes of relating the general problem of the study to the specific problems and stated hypotheses. The review of contemporary programs revealed dissimilarities in the programs of industrial arts education, and subsequently further supported the need for the study.

The review of the cognitive domain was essential in view of the degree of reliance upon the cognitive domain in making decisions about the problem. Perhaps the greatest link between this study (reinforcement of academic disciplines) and the use of the cognitive domain as a classification criteria for the measurement of achievement was in the fact that the nature of abilities and skills in the cognitive domain (including all those levels other than "knowledge") was dependent upon the utilization, relationship, and analysis of previous experience to new situations. This link between industrial arts education and the rest of general education was of primary concern to the treatment curriculum.

CHAPTER III

THE METHOD

I. IDENTIFICATION OF GROUPS

The Department of Industrial Arts and Vocational Education, University of Alberta conducted a study in industrial arts education. A total of ten experimental and ten control classes were identified for purposes of the Department's study. From the twenty classes mentioned above, the writer selected an experimental class of grade nine girls and its matching control class for the purposes of the study reported here. These two classes were labelled, for this study, as the 'treatment group' and 'non-treatment group' respectively.

The treatment group and non-treatment group each initially had an N of twenty-one. The non-treatment group was subsequently reduced by two because the post-treatment data were not available for two students (Appendix B).

The selection of individuals for the classes of the study of the Department of Industrial Arts and Vocational Education was made by the principals of the participating schools. The principals' selections were based upon 1) academic average and intelligence quotient of each student in each class (the principals

attempted to achieve, as closely as possible, equal class means), and 2) administrative limitations as to timetabling and transportation difficulties.

The absence of random sampling selection techniques for selection of individuals for the treatment and non-treatment groups, made it necessary to describe the groups in some detail. A general description of both groups' school and a statistical description of both groups' academic achievements and intelligence quotients follow.

Description of the School

It was requested by the Department of Education that the identity of the home school of the participating students be kept unknown in the description of this study. It is, however, considered necessary to describe the school in general terms. A review of the records of the Department of Education revealed the information found in Table II.

Matching of Groups

The data obtained for the matching of groups include individual marks and scores for each member of both groups as achieved at the end of their eighth grade. A t Test was used to determine the degree of homogeneity of the groups. This is illustrated in Table III.

The test for the homogeneity of the groups indicated a poor

TABLE II

DESCRIPTION OF SCHOOL (1966-67)

SIZE:

Grade	No. of Rooms	No. of Pupils	No. of Teachers
VII	8	226	-
VIII	10	296	-
IX	7	200	-
Total	25	722	33

GRADE NINE COURSES OFFERED:

Compulsory Courses	No. of Pupils	Elective Courses	No. of Pupils
Reading-Literature	200	Home Economics	80
Language	200	Industrial Arts	70*
Social Studies	200	Music	28
Health	200	Oral French	25
Guidance	200	Typing	200
Physical Education	200	Developmental Reading	90
Mathematics	200		
Science	200		

* Does not include those students who participated in the Department of Industrial Arts and Vocational Education research project at the Northern Alberta Institute of Technology laboratories.

TABLE III

PRE-TEST DATA FOR MATCHING

Variable	Treatment N=21		Non-Treatment N=19		t	P Two Tail
	Mean	Std. Dev.	Mean	Std. Dev.		
L.T.* I.Q. (Verbal)	113.05	7.83	110.68	8.11	0.914	0.367
Reading	68.57	7.10	67.05	10.36	0.531	0.598
Literature	66.90	6.81	64.71	8.99	0.835	0.409
Language	69.05	8.81	64.84	8.70	1.478	0.148
Social	62.14	8.67	58.89	10.80	1.026	0.311
Math	69.05	6.29	63.68	10.11	1.983	0.054
Science	63.81	6.71	57.53	8.65	2.514	0.016
I.A. or Home Ec.	64.52	8.30	63.16	7.47	0.531	0.598

*Lorge Thorndike Level 4

match on the scores of mathematics (probability level of 0.054) and science (probability level of 0.016). It was important to note that the difference in performance in science between the treatment and non-treatment groups was in favor of the treatment group. This information was considered when testing for hypothesis # 1 through hypothesis # 6. The analysis of covariance technique employed for analysis of hypothesis # 1 through hypothesis # 6 used the Verbal I.Q. scores and science scores as covariants. This technique was considered essential in light of considerations of the differences between treatment and non-treatment groups.

II. ADMINISTERING TREATMENT

The curricula for the treatment and non-treatment groups have been generally delineated under the headings of 'treatment curriculum' and 'non-treatment curriculum'. It is necessary, however, to describe more fully the curricula. It should be remembered that the educational offerings of the two groups were similar except for the treatment curriculum and non-treatment curriculum. Table IV is a summary of the comparisons of the treatment and non-treatment curricula. The information for Table IV was gathered by 1) direct experience of the writer in administering the treatment curriculum, and 2) an interview with the teacher of the non-treatment curriculum.

TABLE IV

TREATMENT AND NON-TREATMENT CURRICULUM

COMPARISON DATA

Variable	Treatment Curriculum	Non-treatment Curriculum
Self-directed activity	80 min. per week	70 min. per week
Observation	25	40
Cooperative activity	20	10
Total instruction	135	120

NOTES:

Self-directed activity - individual work on experiments or projects

Observation - watching demonstrations, listening to lectures, note-taking, and discussion

Cooperative activity - group work (2 or more pupils) on experiments or projects

III. COLLECTION OF DATA

Pre-Treatment Data

The pre-treatment data consisted of that information which was used to test for homogeneity of groups (Table III). The collection and description of these data was fully presented in the section called "Matching of Groups" (page 28).

Post-Treatment Data

It is important to note that the majority of the post-treatment data were not similar or parallel to the pre-treatment data. The post-treatment data range over a much wider scope.

General grade nine results (parallel to pre-treatment data) were collected by reviewing the permanent record cards of the Department of Education, Government of Alberta. Table V is a summary of these data.

The design of the grid (modelled after Table I, page 4) involved examining the individual items of the June 1967, Grade Nine Science Departmental Examination.* The Department of Education furnished the information for Bloom's objectives and expressed agreement with the items assigned to content areas by this writer. Table VI represents the 'blueprint' for the examination. The entries in Table VI represent the item numbers of the science examination (i.e. 72), and the code numbers for the Taxonomy of Educational Objectives (i.e. 1.10). The science examination consisted

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TABLE V

POST-TEST DATA

Variable	Treatment N=21		Non-treatment N=19		t	P
	Mean	Std. Dev.	Mean	Std. Dev.		Two Tail
L.T.* I.Q. (Verbal)	115.38	8.87	111.84	8.88	1.228	0.227
Reading	57.80	6.33	54.22	5.87	0.905	0.371
Literature	53.72	4.44	57.68	5.58	-1.218	0.231
Language	56.76	10.14	56.95	11.17	-0.054	0.958
Social	52.10	7.41	50.89	8.17	0.475	0.637
Math	57.05	11.80	50.37	12.89	1.667	0.104
Science	54.29	9.91	50.05	9.11	1.366	0.200
I.A. or Home Ec.	68.57	6.20	63.42	14.05	1.485	0.146

* Lorge Thorndike Level 4

TABLE VI

BLUEPRINT OF 'ALL' ITEMS OF THE JUNE, 1967 SCIENCE EXAMINATION

OBJECTIVES	TOPIC or CONTENT AREA									EMPHASIS
	Matter & Energy, Force, Work & Power	Mechanics		Chemical Reactions	Heat	Light	Transportation	Measurement	Science as Inquiry	
		Machines	Fluids							
	1	2	3	4	5	6	7	8	9	
1. KNOWLEDGE	72(1.10) 73(1.12) 74(1.20) 75(1.10) 102(1.00)		79(1.20) 80(1.00) 105(1.00)	33(1.00) 34(1.25) 35(1.10) 36(1.00) 98(1.00)	47(1.30) 48(1.25) 49(1.12) 50(1.20) 51(1.31) 99(1.00)	18(1.12) 19(1.31) 20(1.22) 21(1.00) 22(1.00) 23(1.00) 100(1.00)	62(1.25) 63(1.00) 64(1.30) 67(1.00) 103(1.00)	1(1.20) 3(1.00) 104(1.00)	6(1.25) 7(1.00) 13(1.30) 16(1.10) 101(1.00) 106(1.00)	N=40 37.7%
2. COMPREHENSION	76(2.00) 77(2.10)	84(2.00) 85(2.00) 86(2.00) 87(2.00) 88(2.00) 89(2.10) 90(2.00)	81(2.00)	37(2.00) 38(2.00) 39(2.00) 40(2.00) 41(2.00)	52(2.00) 53(2.00) 54(2.00) 55(2.00) 56(2.00)	24(2.00) 25(2.00) 26(2.00)	65(2.00) 66(2.00) 68(2.00)	2(2.00)	8(2.00) 9(2.00) 10(2.00) 12(2.00)	N=31 29.2%
3. APPLICATION	78(3.00)	91(3.00) 92(3.00) 94(3.00) 95(3.00) 96(3.00) 97(3.00)	82(3.00)	42(3.00) 43(3.00)	57(3.00) 58(3.00) 59(3.00)	27(3.00) 28(3.00) 29(3.00) 30(3.00) 31(3.00)	69(3.00) 70(3.00)	4(3.00)	11(3.00) 17(3.00)	N=23 21.7%
4., 5., and 6. ANALYSIS, SYNTHESIS AND EVALUATION		93(4.00)	83(4.00)	44(4.00) 45(4.00) 46(4.00)	60(4.20) 61(4.00)	32(4.00)	71(4.00)	5(4.00)	14(4.00) 15(5.00)	N=12 11.4%
EMPHASIS	N=8 7.6%	N=14 13.2%	N=6 5.3%	N=15 14.2%	N=16 15.3%	N=16 15.3%	N=11 10.4%	N=6 5.3%	N=14 13.3%	N=106 100%

of one hundred and ten items, four of which were not scored by the Provincial Department of Education because of not being on course content, or because of an error in printing the item. The categories for the "Content" dimension (column headings of Table VI) represent the natural sub-division of the subject matter, for example, the units of the course or adaptations of them. The "Process" dimension (row headings of Table VI) is representative of classifications of Bloom's taxonomy - cognitive domain. The High School Entrance Examination Board (1966, p. 1) expressed some considerations about the classification of the "Process" dimension.

> It must be understood that categorization of items in terms of thought processes is tentative, only, because different students use different processes in responding to a particular item. Also there is sometimes disagreement as to the placement of an item because the categories are not always clear-cut. Ordinarily a category may be considered accurate within one; that is, an item classified as 3.00 is likely no more simple than a class 2.00 item nor more difficult than a class 4.00 item.

The achievement of students on individual items was collected in the following manner. The score sheets for each student were drawn from the files of the Department of Education. The processing of the score sheets was carried out by means of the University of Alberta Division of Educational Research Services, I.B.M. Optical Scoring Reader. The output was in punched card form.

An item analysis of the science examination was obtained from the Department of Education. This analysis was conducted on

a province-wide sample of 1007 (3.6% of total population writing the examination). Processing was carried out by means of the Department of Education's I.B.M. 1230 Optical Scoring Reader and the University of Alberta's I.B.M. 7040 Computer. The results appear in Appendix C. This information was used to determine a list of 'selected' items for analysis, as described in Chapter IV. The list of 'selected' items, those that were considered 'good' test items, were selected according to criteria established by the Department of Education. These criteria were:

(1) The item difficulty (DIF.) must lie between 0.02 and 0.80.

(2) The item reliability index number* (ITEM REL. INDEX #) must lie between 0.15 and 0.30.

(3) Both criteria (1) and (2) must be met.

Table VII shows the new grid containing the 'selected' items only.

Provincial norms for the grade nine science departmental examination were collected from the files of the Department of Education. These statistics were obtained from the same sample of 1007 students as was used for the provincial item analysis. The mean for this sample on the science examination was 55.41, and the

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* This measure was calculated to adjust the value of the Biserial Correlation to account for calculations on items where the Item Difficulty was an extreme value.
Example: for item number 98 of the examination the Item Difficulty was 0.95, the Biserial Correlation was 0.39, and the Item Reliability Index was 0.08. Without the correction factor described here the calculated Biserial Correlation would be misleading.

TABLE VII

BLUEPRINT OF 'SELECTED' ITEMS OF THE JUNE, 1967 SCIENCE EXAMINATION

TOPIC or CONTENT AREA

OBJECTIVES	Matter & Energy, Force, Work & Power	Mechanics		Chemical Reactions	Heat	Light	Transportation	Measurement	Science as Inquiry	EMPHASIS
		Machines	Fluids							
	1	2	3	4	5	6	7	8	9	
1. KNOWLEDGE	72(1.10) 73(1.12) 74(1.20) 75(1.10) 102(1.00)		82(1.20)	33(1.00) 35(1.10) 36(1.00)	47(1.30) 48(1.25) 49(1.12) 50(1.20) 51(1.31) 99(1.00)	18(1.12) 20(1.22) 21(1.00) 23(1.00)	62(1.25) 63(1.00) 67(1.00) 103(1.00)	3(1.00)	13(1.30) 16(1.10) 106(1.00)	N=27 42.0%
2. COMPREHENSION	76(2.00) 77(2.10)	86(2.00) 88(2.00) 89(2.00)		37(2.00) 38(2.00) 39(2.00) 40(2.00)	52(2.00) 53(2.00) 54(2.00) 55(2.00) 56(2.00)	24(2.00) 25(2.00)	65(2.00) 66(2.00)	2(2.00)	8(2.00)	N=20 30.2%
3. APPLICATION		91(3.00) 97(3.00) 100(3.00)	82(3.00)		57(3.00) 58(3.00)	27(3.00) 28(3.00) 29(3.00) 30(3.00)	69(3.00)	4(3.00)		N=12 18.2%
4., 5., and 6. ANALYSIS, SYNTHESIS AND EVALUATION			86(4.00)		60(4.20) 61(4.00)	32(4.00)	74(4.00)		14(4.00) 15(5.00)	N=7 10.6%
EMPHASIS	N=7 10.7%	N=6 9.1%	N=3 4.5%	N=7 10.7%	N=15 22.8%	N=11 16.7%	N=8 12.2%	N=3 4.5%	N=6 9.1%	N=66 100%

standard deviation was 15.26. Appendix D shows a complete listing of the frequencies, Z scores, and percentiles for the provincial sample (3.6%).

CHAPTER IV

PRESENTATION AND TREATMENT OF DATA

INTRODUCTION

This study was conducted to investigate, specifically, whether the treatment of the University of Alberta's new Industrial Arts program had an affect upon a learner's achievement in science. Achievement in science was measured according to responses on the Department of Education's Science Examination and analysed in terms of "Content" and "Processes" (from Bloom's Cognitive Domain). Many hypotheses for investigation arise from the combinations generated within the 'grid' (see page 4). Refinement of the investigation was achieved by further delineating the 'grid' to remove from it those items of the science examination which were judged to be "poor" items (according to criteria defined by the Department of Education).

The investigation of each hypothesis is summarized here, with comparisons of data from the total items and the selected items where applicable.

The data was processed on the I.B.M. 360-67 Computer at the Department of Computing Science, University of Alberta, using programs from the Division of Educational Research Services.

I. ANALYSIS OF HYPOTHESES

The nine hypotheses presented in this study were tested by two major statistical techniques. Hypotheses # 1 through # 6 were tested by use of the technique known as analysis of covariance. For each hypothesis in which an analysis of covariance was used, two examinations were conducted; the first on 'all' items of the science examination, and the second only on the 'selected' items of the science examination. In the analysis of covariance, Verbal I.Q. scores and science scores (pre-test data) were used as co-variates.

Hypotheses # 7 through # 9 were tested differently from the first six hypotheses. For hypotheses # 7 through # 9 a one-way analysis of variance was performed on the difference between treatment group item difficulties (converted to unit normal deviates) and provincial sample item difficulties.

Analysis of Covariance

The analysis of covariance was handled in the following manner.

1. Statistical statement of the hypothesis was:

   H_o: $\mu_1' - \mu_2' = 0$; H_1: $\mu_1' \neq \mu_2'$

2. Level of significance was set *a priori* at 0.05.
3. The decision rule was: if $F^{1}_{36} \geq 4.11$, then the null hypothesis was rejected.

4. Computation was processed on the I.B.M. 360/67 Computer at the Department of Computing Science using programs from the Division of Educational Research Services. Computation was based upon the method described by Ferguson (1959). A summary of the analysis of covariance for hypotheses # 1 through # 6 follows.

Hypothesis # 1 was concerned with performance of the treatment and non-treatment groups on the total grade nine science examination, that is, including items from each of the Cognitive Domain classifications.

The null statistical hypothesis was: $H_o: \mu_1' - \mu_2' = 0$; where μ_1' = adjusted population mean of the treatment group, and where μ_2' = adjusted population mean of the non-treatment group.

The analysis of covariance on data from 'all' items of the total examination is summarized in Table VIII. According to the decision criteria established, H_o was not rejected. The observation was made that there was no significant difference in performance between the treatment and non-treatment groups on 'all' items of the science examination.

The analysis of covariance on data from 'selected' items of the total examination is summarized in Table IX. According to the decision criteria established, H_o was not rejected. The observation was made that there was no significant difference in performance between the treatment and non-treatment groups on 'selected' items of the science examination.

TABLE VIII

SCIENCE - "ALL" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	54.29	51.51
Non-Treatment	19	57.53	50.05	53.12

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	22.45	0.566	0.457
Within	36	39.62		

TABLE IX

SCIENCE - "SELECTED" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	35.81	33.87
Non-Treatment	19	57.53	31.32	33.46

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	1.50	0.039	0.845
Within	36	38.78		

Hypothesis # 2 was concerned with performance of the treatment and non-treatment groups on items of the grade nine science departmental examination classified as representative of the "knowledge" process of Bloom's Cognitive Domain.

The null statistical hypothesis was: H_o: $\mu_1' - \mu_2' = 0$; where μ_1' = adjusted population mean of the treatment group, and where μ_2' = adjusted population mean of the non-treatment group.

The analysis of covariance on data from 'all' items within the "knowledge" classification of the examination is summarized in Table X. According to the decision criteria established, H_o was not rejected. The observation was made (as was hypothesized) that there was no significant difference in performance between the treatment and non-treatment groups on 'all' items of the science examination classified as representative of the "knowledge" process of Bloom's Cognitive Domain.

The analysis of covariance on data from 'selected' items within the "knowledge" classification of the examination is summarized in Table XI. According to the decision criteria established, H_o was not rejected. The observation was made (as was hypothesized) that there was no significant difference in performance between the treatment and non-treatment groups on 'selected' items of the science examination classified as representative of the "knowledge" process of Bloom's Cognitive Domain.

TABLE X

KNOWLEDGE - "ALL" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	21.05	20.20
Non-Treatment	19	57.53	20.11	21.04

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	5.95	0.512	0.479
Within	36	11.62		

TABLE XI

KNOWLEDGE - "SELECTED" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	14.24	13.58
Non-Treatment	19	57.53	13.37	14.10

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	2.33	0.313	0.579
Within	36	7.45		

<u>Hypothesis # 3</u> was concerned with performance of the treatment and non-treatment groups on items of the grade nine science departmental examination classified as representative of the "comprehension" process of Bloom's Cognitive Domain.

The null statistical hypothesis was: H_o: $\mu_1' - \mu_2' = 0$; where μ_1' = adjusted population mean of the treatment group, and where μ_2' = adjusted population mean of the non-treatment group.

The analysis of covariance on data from 'all' items within the "comprehension" classification of the examination is summarized in Table XII. According to the decision criteria established, H_o was not rejected. The observation was made that there was no significant difference in performance between the treatment and non-treatment groups on 'all' items of the science examination classified as representative of the "comprehension" process of Bloom's Cognitive Domain.

The analysis of covariance on data from 'selected' items within the "comprehension" classification of the examination is summarized in Table XIII. According to the decision criteria established, H_o was not rejected. The observation was made that there was no significant difference in performance between the treatment and non-treatment groups on 'selected' items of the science examination classified as representative of the "comprehension" process of Bloom's Cognitive Domain.

TABLE XII

COMPREHENSION - "ALL" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	16.67	16.01
Non-Treatment	19	57.53	15.21	15.94

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	0.04	0.003	0.956
Within	36	13.01		

TABLE XIII

COMPREHENSION - "SELECTED" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	10.67	10.07
Non-Treatment	19	57.53	9.53	10.19

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	0.12	0.011	0.917
Within	36	10.4		

Hypothesis # 4 was concerned with performance of the treatment and non-treatment groups on items of the grade nine science departmental examination classified as representative of the "application" process of Bloom's Cognitive Domain.

The null statistical hypothesis was: $H_o: \mu_1' - \mu_2' = 0$; where μ_1' = adjusted population mean of the treatment group, and where μ_2' = adjusted population mean of the non-treatment group.

The analysis of covariance on data from 'all' items within the "application" classification of the examination is summarized in Table XIV. According to the decision criteria established H_o was not rejected. The observation was made that there was no significant difference in performance between the treatment and non-treatment groups on 'all' items of the science examination classified as representative of the "application" process of Bloom's Cognitive Domain.

The analysis of covariance on data from 'selected' items within the "application" classification of the examination is summarized in Table XV. According to the decision criteria established, H_o was not rejected. The observation was made that there was no significant difference in performance between the treatment and non-treatment groups on 'selected' items of the science examination classified as representative of the "application" process of Bloom's Cognitive Domain.

TABLE XIV

APPLICATION - "ALL" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	9.38	8.80
Non-Treatment	19	57.53	9.58	10.23

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	17.60	2.40	0.130
Within	36	7.33		

TABLE XV

APPLICATION - "SELECTED" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	6.38	5.89
Non-Treatment	19	57.53	5.42	5.96

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	0.04	0.014	0.907
Within	36	0.30		

Hypothesis # 5 was concerned with performance of the treatment and non-treatment groups on items of the grade nine science departmental examination classified as representative of the "analysis, synthesis and evaluation" processes of Bloom's Cognitive Domain.

The null statistical hypothesis was: $H_o: \mu_1' - \mu_2' = 0$; where μ_1' = adjusted population mean of the treatment group, and where μ_2' = adjusted population mean of the non-treatment group.

The analysis of covariance on data from 'all' items within the "analysis, synthesis and evaluation" classification of the examination is summarized in Table XVI. According to the decision criteria established, H_o was rejected in favour of the alternate hypothesis H_1 . It was observed that there was a difference in performance between the treatment and non-treatment groups on 'all' items of the science examination classified as representative of the "analysis, synthesis and evaluation" processes of Bloom's Cognitive Domain. The difference was in favour of the treatment group.

The analysis of covariance on data from 'selected' items within the "analysis, synthesis and evaluation" classification of the examination is summarized in Table XVII. According to the decision criteria established, H_o was rejected in favour of the alternate hypothesis, H_1 . It was observed that there was a difference in performance between the treatment and non-treatment groups on 'selected' items of the science examination classified as representative of the "analysis, synthesis and evaluation" processes of Bloom's Cognitive Domain. The difference was in favour of the treatment group.

TABLE XVI

ANALYSIS, SYNTHESIS & EVALUATION - "ALL" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	6.72	6.48
Non-Treatment	19	57.53	4.63	4.89

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	21.50	6.19	0.018
Within	36	3.48		

TABLE XVII

ANALYSIS, SYNTHESIS & EVALUATION - "SELECTED" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	4.52	4.33
Non-Treatment	19	57.53	3.00	3.21

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	10.69	5.85	0.021
Within	36	1.83		

TABLE XVIII

CONTENT - "ALL" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	18.14	17.17
Non-Treatment	19	57.53	17.05	18.13

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	7.86	0.676	0.416
Within	36	11.62		

TABLE XIX

CONTENT - "SELECTED" ITEMS

	N	Pretest Mean	Post Test Mean	Post Test Adj. Mean
Treatment	21	63.81	11.90	11.22
Non-Treatment	19	57.53	10.53	11.28

ANALYSIS OF COVARIANCE

Source	D.F.	Mean Sq.	F	P
Between	1	0.03	0.005	0.945
Within	36	0.63		

<u>Hypothesis # 6</u> was concerned with performance of the treatment and non-treatment groups on items of the grade nine science departmental examination classified as representative of the content areas of "mechanics", "transportation", and "matter and energy, force, work, and power".

The null statistical hypothesis was: $H_o: \mu_1' - \mu_2' = 0$; where μ_1' = adjusted population mean of the treatment group, and where μ_2' = adjusted population mean of the non-treatment group.

The analysis of covariance on data from 'all' items within the content areas listed above, is summarized in Table XVIII. According to the decision criteria established, H_o was not rejected. It was observed that there was no significant difference in performance between the treatment and non-treatment groups on 'all' items of the science examination classified as representative of the content areas of "mechanics", "transportation", and "matter and energy, force, work, and power".

The analysis of covariance on data from 'selected' items within the content areas listed above, is summarized in Table XIX. According to the decision criteria established, H_o was not rejected. It was observed that there was no significant difference in performance between the treatment and non-treatment groups on 'selected' items of the science examination classified as representative of the content areas of "mechanics", "transportation", and "matter and energy, force, work and power".

One-way Analysis of Variance

A one-way analysis of variance was used to analyze hypotheses # 7 through # 9. The analysis employed the technique of computing unit normal deviate equivalents of item difficulties for both the treatment group and the 3.6% (N = 1007) provincial sample. 'Item difficulty' is defined as the proportion of people answering an item correctly. They are expressed as an index in the range 0.00 to 1.00. Because the distribution of item difficulties is necessarily restricted, it was decided to convert them to unit normal deviates; thus, an item difficulty of 0.5 would have a value of 0.00, an item difficulty of 0.84 would have a value of +1.00, and so on.

Because of the very nature of the taxonomic structure of the items, it was felt that "knowledge" items should be intrinsically less difficult than "comprehension" items, which in turn should be less difficult than "application" items, and so on, with "analysis, synthesis and evaluation" items being the most difficult. To overcome this problem it was decided to subtract the unit normal deviates, corresponding to item difficulties, for the provincial sample from those of the treatment group. In this way a measure of item difficulty relative to provincial norms was calculated. In a sense, this would serve to partial out any intrinsic differences in item difficulties among the four categories of items and provide an indication of whether or not the treatment group responded

unexpectedly higher on one class of items than on another, where 'unexpectedly' means unexpected on the basis of the provincial sample. We can define this statistic as "relative item difficulty".

A one-way analysis of variance was carried out on the deviations of observed unit normal deviate equivalents of item difficulties for each of the four groups of items. The purpose of this seemingly complicated analysis was to determine whether or not the treatment group did unexpectedly better on "analysis, synthesis and evaluation" items than on: "knowledge" items (hypothesis # 7), "comprehension" items (hypothesis # 8), and "application" items (hypothesis # 9).

The means and standard deviations of the deviations of observed unit normal deviate equivalents of item difficulties for each of the groups of items are shown in Table XX.

The results of the one-way analysis of variance are shown on Table XXI. No significant difference among relative item difficulties was observed. However, reference to Table XX shows that the mean relative difficulty for "analysis, synthesis and evaluation" items is higher than for "knowledge", "comprehension", and "application" items. While the statistical test gives one no reason to believe that this is other than chance (sampling) variations, it is heartening in light of the earlier prediction in hypothesis # 9 (page 5).

TABLE XX

MEANS AND STANDARD DEVIATIONS OF THE DEVIATIONS OF OBSERVED UNIT NORMAL DEVIATE EQUIVALENTS OF ITEM DIFFICULTIES

Cognitive Domain Level	Mean	S.D.
1. Knowledge	-0.012	0.572
2. Comprehension	-0.180	0.574
3. Application	-0.191	0.685
4. Analysis, Synthesis and Evaluation	0.188	0.483
TOTAL	-0.077	0.603

TABLE XXI

ONE-WAY ANALYSIS OF VARIANCE OF RELATIVE ITEM DIFFICULTIES

Source	SS	MS	D.F.	F	P
Groups	1.640	0.55	3.0	1.51	0.216
Error	36.874	0.36	102.0		

CHAPTER V

RESULTS, DISCUSSION, IMPLICATIONS AND SUMMARY

I. RESULTS

The results of the study are presented in relationship to the nine stated hypotheses. A summary of the results is tabulated and presented in Table XXII. The "prediction" column in Table XXII shows "good" or "poor" selection in reference to the expectations of the writer as expressed for each of the nine hypotheses. It was noted that the results, as tabulated in Table XXII, were presented independently of judgemental or educational implications. The conclusions and discussion, which follow, took into account the judgemental implications pertaining to this study.

II. CONCLUSIONS AND DISCUSSION

It was felt by the writer that only indications of areas of reinforcement of academic disciplines, by the participation of students in an industrial arts program, were found in this study. Reported here, then, are the indications which were revealed by the study.

The analysis of covariance, applied to hypotheses # 1 through # 6, revealed the following results

TABLE XXII

SUMMARY OF RESULTS

ANALYSIS OF COVARIANCE:

HYPOTHESES	NULL HYPOTHESES (values of P)		REJECTION DECISION IN FAVOUR OF:		PREDICTION	
	rejected	not rejected	Treatment group	Non-treatment group	'good'	'poor'
#1 all items		0.457				✓
selected items		0.845				✓
#2 all items		0.479			✓	
selected items		0.579			✓	
#3 all items		0.956				✓
selected items		0.917				✓
#4 all items		0.130				✓
selected items		0.907				✓
#5 all items	0.018		✓		✓	
selected items	0.021		✓		✓	
#6 all items		0.416				✓
selected items		0.945				✓

ONE-WAY ANALYSIS OF VARIANCE

HYPOTHESES	NULL HYPOTHESES		REJECTION DECISION IN FAVOUR OF:		PREDICTION	
	rejected	not rejected	Treatment group	Non-treatment group	'good'	'poor'
#7 all items		✓				✓
#8 all items		✓				✓
#9 all items		✓				✓

No differentiation in performance on all items of the grade nine science departmental examination between the treatment and non-treatment groups was found. As was hypothesized, there was no differentiation in performance between the treatment and non-treatment groups on the "knowledge" items (approximately weighted 37.7%) of the examination. The proportionally large weighting effect of the "knowledge" items, and the fact that reinforcement of learning measured by "knowledge" items was expected to be not significant, forced the discussion of the study to be more concerned with results pertaining to the other hypotheses.

The only area of analysis exhibiting significant difference revealed by the analysis of covariance was for hypothesis # 5. The analysis related to hypothesis # 5 revealed differences in performance between the treatment and non-treatment groups, on items of the examination classified according to Bloom's Cognitive Domain as "analysis, synthesis and evaluation". The difference was in favour of the treatment group and the probability levels (0.018 for 'all' items and 0.021 for 'selected' items) were judged to be small enough to conclude that the difference was not due to chance sampling. Significant difference in behavior on items of the "analysis, synthesis and evaluation" classification was judged to be very encouraging towards accepting the possibility that the treatment curriculum does, in fact, reinforce learning associated with the higher levels of the cognitive domain.

It was worth noting that no significant difference between treatment and non-treatment groups was found in performance on the 'selected' classification areas of "content" on the grade nine science departmental examination (hypothesis # 6).

The one-way analysis of variance applied to the analysis of data relative to hypotheses # 7, # 8 and # 9, revealed no 'unexpectedly' higher responses on one class of items than on any other class of items.

There may be some subjective evidence that the treatment group was somewhat more proficient in responding to "analysis, synthesis and evaluation" items than to items lower on the taxonomic scale, but the chance factor of sampling cannot be ruled out.

III. SUMMARY OF THE STUDY

The general problem of this study was to identify the existence of structure in industrial arts education. Delineation of this large general problem, led to an attempt to look at the relationship of one of the objectives of the University of Alberta's Industrial Arts program as it related to objectives of other disciplines in general education (external structure). The objective, "to provide an environment where students can reinforce and apply the academic disciplines," was selected as the objective for study.

The method employed in this study was to administer the

program of industrial arts education to a treatment group and compare the treatment group's subsequent achievement in grade nine science with that of a control group and of a provincial sample group.

An analysis of covariance was used to examine data relevant to the first six stated hypotheses, while a one-way analysis of variance was used to examine the data relevant to the last three stated hypotheses.

The results showed that an attempt to differentiate between achievement of the respective groups of students on the total science examination revealed no significant differences. However, it was shown that the items designed to test for learning representative of the highest three levels of Bloom's Cognitive Domain were answered significantly better by the treatment group than by the non-treatment group.

There was no significant difference in the responses of the treatment group on higher level items than on lower level items, as compared to the responses of the provincial sample. There was, however, evidence that the treatment group was somewhat more proficient in responding to the "analysis, synthesis and evaluation" items than to the other classifications of items.

The relationship between the objective - "To provide an environment where students can reinforce and apply the academic disciplines." - and the objectives of the other disciplines in

general education was seen as a complementary relationship. Evidence, revealed in this study, of the existence of this complementary relationship suggests that the program of Industrial Arts Education of the University of Alberta may, in fact, have a structure.

Limitations of this study would affect any further generalizations; and certainly, further study into the general problem is needed.

IV. LIMITATIONS AND FURTHER RESEARCH

The major limitations of this study are related to the sampling techniques, and to the control of the treatment and non-treatment activities.

Pre-test data showed that the matching of groups was poor. This poor matching of groups was probably due, in part, to poor or inexact assignment of students to the groups by the principal (see page 27 for the selection technique).

The scores obtained on the pre-test for science (Table III, p. 30) was a major factor against obtaining good matching of the groups. Random sampling techniques should have been employed. A group of students should have been identified and then assigned to one or the other of the groups at random. Matching is never a substitute for randomization; and the random assignment of subjects to treatments, at some stage, is almost always necessary for

determining causal relationships.

The treatment and non-treatment activities of a study, must be kept under tight control. Table IV, page 32, showed that the treatment curriculum was administered one-quarter of an hour longer each week than the non-treatment curriculum. This amounted to one-eighth more time each week. Thirty-eight weeks of class time were available for each of the treatments, resulting in a total of nine and one-half hours more time being spent by students in the treatment curriculum than by students in the non-treatment curriculum.

It must be noted, however, that the program of industrial arts offered by the Department of Industrial Arts and Vocational Education proposes to achieve its objectives with two years of study in the curriculum at the level used as the treatment curriculum for the study reported here. Time and cost factors for the treatment and non-treatment activities should be kept as close to identical as possible. The non-treatment activity for the study reported here would have been more valid had it been additional time spent in science curriculum, rather than Home Economics curriculum studies.

Familiarity with the types of environment might have been a factor in this study. Girls may have required a longer familiarity period in the environment of the treatment curriculum, than for the environment of the non-treatment curriculum. This is suggested

because the girls of both treatment and non-treatment groups had all previously (the year before) participated in a Home Economics class.

The grade nine science departmental examination was probably one of the most valid measurement devices that was available. In addition, it would have been useful to use a measurement device to attempt to measure how a student made a decision on the items of the science examination.

The analyses employed in this study were judged to be sufficient.

Refinement to techniques of research are always possible. The degree of refinement necessary must be weighed in light of economy, and expected results. If costs become excessive, due to refinement, a better alternative might be to re-design the nature of the study being considered. It was felt that the limitations of this study were not excessive in light of the nature of the expected results, and that the results found have value in indicating possible further study into the 'general problem'.

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APPENDIX A

Condensed Version of the
Taxonomy of Educational Objectives

Cognitive Domain

KNOWLEDGE

1.00 KNOWLEDGE

Knowledge, as defined here, involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure, or setting. For measurement purposes, the recall situation involves little more than bringing to mind the appropriate material. Although some alteration of the material may be required, this is a relatively minor part of the task. The knowledge objectives emphasize most the psychological processes of remembering. The process of relating is also involved in that a knowledge test situation requires the organization and reorganization of a problem such that it will furnish the appropriate signals and cues for the information and knowledge the individual possesses. To use an analogy, if one thinks of the mind as a file, the problem in a knowledge test situation is that of finding in the problem or task the appropriate signals, cues, and clues which will most effectively bring out whatever knowledge is filed or stored.

1.10 KNOWLEDGE OF SPECIFICS

The recall of specific and isolable bits of information. The emphasis is on symbols with concrete referents. This material, which is at a very low level of abstraction, may be thought of as the elements from which more complex and abstract forms of knowledge are built.

1.11 KNOWLEDGE OF TERMINOLOGY

Knowledge of the referents for specific symbols (verbal and non-verbal). This may include knowledge of the most generally accepted symbol referent, knowledge of the variety of symbols which may be used for a single referent, or knowledge of the referent most appropriate to a given use of a symbol.

*To define technical terms by giving their attributes, properties, or relations.

*Familiarity with a large number of words in their common range of meanings.

1.12 KNOWLEDGE OF SPECIFIC FACTS

Knowledge of dates, events, persons, places, etc. This may include very precise and specific information such as the specific date or exact magnitude of a phenomenon. It may also include approximate or relative information such as an

*Illustrative educational objectives selected from the literature.

approximate time period or the general order of magnitude of a phenomenon.

*The recall of major facts about particular cultures.

*The possession of a minimum knowledge about the organisms studied in the laboratory.

1.20 KNOWLEDGE OF WAYS AND MEANS OF DEALING WITH SPECIFICS

Knowledge of the ways of organizing, studying, judging, and criticizing. This includes the methods of inquiry, the chronological sequences, and the standards of judgment within a field as well as the patterns of organization through which the areas of the fields themselves are determined and internally organized. This knowledge is at an intermediate level of abstraction between specific knowledge on the one hand and knowledge of universals on the other. It does not so much demand the activity of the student in using the materials as it does a more passive awareness of their nature.

1.21 KNOWLEDGE OF CONVENTIONS

Knowledge of characteristic ways of treating and presenting ideas and phenomena. For purposes of communication and consistency, workers in a field employ usages, styles, practices, and forms which best suit their purposes and/or which appear to suit best the phenomena with which they deal. It should be recognized that although these forms and conventions are likely to be set up on arbitrary, accidental, or authoritative bases, they are retained because of the general agreement or concurrence of individuals concerned with the subject, phenomena, or problem.

*Familiarity with the forms and conventions of the major types of works, e.g., verse, plays, scientific papers, etc.

*To make pupils conscious of correct form and usage in speech and writing.

1.22 KNOWLEDGE OF TRENDS AND SEQUENCES

Knowledge of the processes, directions, and movements of phenomena with respect to time.

*Understanding of the continuity and development of American culture as exemplified in American life.

*Knowledge of the basic trends underlying the development of public assistance programs.

1.23 KNOWLEDGE OF CLASSIFICATIONS AND CATEGORIES

Knowledge of the classes, sets, divisions, and arrangements which are regarded as fundamental for a given subject field, purpose, argument, or problem.

*To recognize the area encompassed by various kinds of problems or materials.

*Becoming familiar with a range of types of literature.

1.24 KNOWLEDGE OF CRITERIA

Knowledge of the criteria by which facts, principles, opinions, and conduct are tested or judged.

*Familiarity with criteria for judgment appropriate to the type of work and the purpose for which it is read.

*Knowledge of criteria for the evaluation of recreational activities.

1.25 KNOWLEDGE OF METHODOLOGY

Knowledge of the methods of inquiry, techniques, and procedures employed in a particular subject field as well as those employed in investigating particular problems and phenomena. The emphasis here is on the individual's knowledge of the method rather than his ability to use the method.

*Knowledge of scientific methods for evaluating health concepts.

*The student shall know the methods of attack relevant to the kinds of problems of concern to the social sciences.

1.30 KNOWLEDGE OF THE UNIVERSALS AND ABSTRACTIONS IN A FIELD

Knowledge of the major schemes and patterns by which phenomena and ideas are organized. These are the large structures, theories, and generalizations which dominate a subject field or which are quite generally used in studying phenomena or solving problems. These are at the highest levels of abstraction and complexity.

1.31 KNOWLEDGE OF PRINCIPLES AND GENERALIZATIONS

Knowledge of particular abstractions which summarize observations of phenomena. These are the abstractions which are of value in explaining, describing, predicting, or in determining the most appropriate and relevant action or direction to be taken.

*Knowledge of the important principles by which our experience with biological phenomena is summarized.

*The recall of major generalizations about particular cultures.

1.32 KNOWLEDGE OF THEORIES AND STRUCTURES

Knowledge of the body of principles and generalizations together with their interrelations which present a clear, rounded, and systematic view of a complex phenomenon, problem, or field. These are the most abstract formulations, and they can be used to show the interrelation and organization of a great range of specifics.

*The recall of major theories about particular cultures.

*Knowledge of a relatively complete formulation of the theory of evolution.

INTELLECTUAL ABILITIES AND SKILLS

Abilities and skills refer to organized modes of operation and generalized techniques for dealing with materials and problems. The materials and problems may be of such a nature that little or no specialized and technical information is required. Such information as is required can be assumed to be part of the individual's general fund of knowledge. Other problems may require specialized and technical information at a rather high level such that specific knowledge and skill in dealing with the problem and the materials are required. The abilities and skills objectives emphasize the mental processes of organizing and reorganizing material to achieve a particular purpose. The materials may be given or remembered.

2.00 COMPREHENSION

This represents the lowest level of understanding. It refers to a type of understanding or apprehension such that the individual knows what is being communicated and can make use of the material or idea being communicated without necessarily relating it to other material or seeing its fullest implications.

2.10 TRANSLATION

Comprehension as evidenced by the care and accuracy with which the communication is paraphrased or rendered from one one language or form of communication to another. Translation is judged on the basis of faithfulness and accuracy, that is, on the extent to which the material in the original communication is preserved although the form of the communication has been altered.

*The ability to understand non-literal statements (metaphor, symbolism, irony, exaggeration).

*Skill in translating mathematical verbal material into symbolic statements and vice versa.

2.20 INTERPRETATION

The explanation or summarization of a communication. Whereas translation involves an objective part-for-part rendering of a communication, interpretation involves a reordering, rearrangement, or a new view of the material.

*The ability to grasp the thought of the work as a whole at any desired level of generality.

*The ability to interpret various types of social data.

2.30 EXTRAPOLATION

The extension of trends or tendencies beyond the given data to determine implications, consequences, corollaries, effects, etc., which are in accordance with the conditions described in the original communication.

*The ability to deal with the conclusions of a work in terms of the immediate inference made from the explicit statements.

*Skill in predicting continuation of trends.

3.00 APPLICATION

The use of abstractions in particular and concrete situations. The abstractions may be in the form of general ideas, rules of procedures, or generalized methods. The abstractions may also be technical principles, ideas, and theories which must be remembered and applied.

*Application to the phenomena discussed in one paper of the scientific terms or concepts used in other papers.

*The ability to predict the probable effect of a change in a factor on a biological situation previously at equilibrium.

4.00 ANALYSIS

The breakdown of a communication into its constituent elements or parts such that the relative hierarchy of ideas is made clear and/or the relations between the ideas expressed are made explicit. Such analyses are intended to clarify the communication, to indicate how the communication is organized, and the way in which it manages to convey its effects, as well as its basis and arrangement.

4.10 ANALYSIS OF ELEMENTS

Identification of the elements included in a communication.

*The ability to recognize unstated assumptions.

*Skill in distinguishing facts from hypotheses.

4.20 ANALYSES OF RELATIONSHIPS

The connections and interactions between elements and parts of a communication.

*Ability to check the consistency of hypotheses with given information and assumptions.

*Skill in comprehending the interrelationships among the ideas in a passage.

4.30 ANALYSIS OF ORGANIZATIONAL PRINCIPLES

The organization, systematic arrangement, and structure which hold the communication together. This includes the "explicit" as well as "implicit" structure. It includes the bases, necessary arrangement, and the mechanics which make the communication a unit.

*The ability to recognize form and pattern in literary or artistic works as a means of understanding their meaning.

*Ability to recognize the general techniques used in persuasive materials, such as advertising, propaganda, etc.

5.00 SYNTHESIS

The putting together of elements and parts so as to form a whole. This involves the process of working with pieces, parts, elements, etc., and arranging and combining them in such a way as to constitute a pattern or structure not clearly there before.

5.10 PRODUCTION OF A UNIQUE COMMUNICATION

The development of a communication in which the writer or speaker attempts to convey ideas, feelings, and/or experiences to others.

*Skill in writing, using an excellent organization of ideas and statements.

*Ability to tell a personal experience effectively.

5.20 PRODUCTION OF A PLAN, OR PROPOSED SET OF OPERATIONS

The development of a plan of work or the proposal of a plan of operations. The plan should satisfy requirements of the task which may be given to the student or which he may develop for himself.

*Ability to propose ways of testing hypotheses.

*Ability to plan a unit of instruction for a particular teaching situation.

5.30 DERIVATION OF A SET OF ABSTRACT RELATIONS

The development of a set of abstract relations either to classify or explain particular data or phenomena, or the deduction of propositions and relations from a set of basic propositions or symbolic representations.

*Ability to formulate appropriate hypotheses based upon an analysis of factors involved, and to modify such hypotheses in the light of new factors and considerations.

*Ability to make mathematical discoveries and generalizations.

6.00 EVALUATION

Judgments about the value of material and methods for given purposes. Quantitative and qualitative judgments about the extent to which material and methods satisfy criteria. Use of a standard of appraisal. The criteria may be those determined by the student or those which are given to him.

6.10 JUDGMENTS IN TERMS OF INTERNAL EVIDENCE

Evaluation of the accuracy of a communication from such evidence as logical accuracy, consistency, and other internal criteria.

*Judging by internal standards, the ability to assess general probability of accuracy in reporting facts from the care given to exactness of statement, documentation, proof, etc.

*The ability to indicate logical fallacies in arguments.

6.20 JUDGMENTS IN TERMS OF EXTERNAL CRITERIA

Evaluation of material with reference to selected or remembered criteria.

*The comparison of major theories, generalizations, and facts about particular cultures.

*Judging by external standards, the ability to compare a work with the highest known standards in its field--especially with other works of recognized excellence.

APPENDIX B

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF EDUCATION

REFER TO FILE NO.

ADMINISTRATION BUILDING
10820 - 98 AVENUE
EDMONTON, ALBERTA

EX-68 STN/da

March 19, 1968

Dear Sir:

Re: Virgie L. YEATES and Cherie J. HORTIE

Grade IX Science scores were not obtained from the Department of Education for the above-mentioned students for the following reasons:

Virgie Loree Yeates did not write any Grade IX Departmental examinations in 1967 and Cherie Jacqueline Hortie's Science paper has been misfiled and cannot be found.

APPENDIX C

ITEM ANALYSIS OF THE 1967 GRADE NINE SCIENCE DEPARTMENTAL EXAMINATION

This examination was administered to 27,982 Alberta grade nine students. One hundred and six items were scored. The item analysis of this examination was carried out by the Department of Education, Government of Alberta. A province wide representative sample of 1007 students was selected for the analysis.

A sample of the computer print-out from this analysis is shown below.

SAMPLE PRINT-OUT - ITEM #2

ITEM	N	OMIT	DIF		NR	K	1	2	3	4
2	1007	14.0	0.379			3	187	69	382	355
			UPPER	5	1		5	12	119	42
			UPPER	4	1		15	23	99	72
			UPPER	3	4		34	15	71	83
			UPPER	2	3		55	6	53	85
			UPPER	1	5		78	13	40	73
TEST SCORE MEANS							45.1	58.3	62.0	53.6
Z-SCORE MEANS				-0.31			-0.56	0.21	0.41	-0.01
BISERIAL CORREL #				0.427						
ITEM REL. INDEX #				0.207						

The above sample of responses gives a summary of how the students answered the question posed by the item. The five achievement levels were selected according to the following.

Level 1 - below a score of 41.00.

Level 2 - between scores of 41.00 and 50.00.

Level 3 - between scores of 50.00 and 59.00.

Level 4 - between scores of 59.00 and 70.00.

Level 5 - above a score of 70.00.

Determination of "selected" items for analysis, as described in Chapter IV, was based upon the following summary.

SUMMARY OF SELECTED ITEMS

ITEM	GRID LOCATION ROW	COL.	DIFFICULTY	ITEM REL. INDEX #	ITEMS NOT SELECTED
1	1	8	0.84	0.21	*
2	2	8	0.38	0.21	
3	1	8	0.71	0.22	
4	3	8	0.74	0.19	
5	4	8	0.64	0.14	**
6	1	9	0.34	0.04	**
7	1	9	0.27	0.15	
8	2	9	0.58	0.15	
9	2	9	0.61	0.13	**
10	2	9	0.37	0.02	**
11	3	9	0.55	0.06	**
12	2	9	0.81	0.20	*
13	1	9	0.59	0.27	
14	4	9	0.53	0.15	
15	4	9	0.52	0.16	
16	1	9	0.52	0.20	
17	3	9	0.44	0.10	**
18	1	6	0.74	0.16	
19	1	6	0.62	0.13	**
20	1	6	0.53	0.25	
21	1	6	0.64	0.17	
22	1	6	0.41	0.14	**
23	1	6	0.76	0.25	
24	2	6	0.62	0.22	
25	2	6	0.71	0.23	
26	2	6	0.16	0.17	*
27	3	6	0.56	0.17	
28	3	6	0.57	0.18	
29	3	6	0.35	0.20	
30	3	6	0.61	0.30	
31	3	6	0.24	0.09	**
32	4	6	0.64	0.18	

* Items not selected; outside range for DIFFICULTY.
** Items not selected; outside range for ITEM REL. INDEX #.

ITEM	GRID LOCATION ROW	COL.	DIFFICULTY	ITEM REL. INDEX #	ITEMS NOT SELECTED
33	1	4	0.65	0.34	
34	1	4	0.91	0.13	***
35	1	4	0.70	0.28	
36	1	4	0.56	0.24	
37	2	4	0.62	0.26	
38	2	4	0.39	0.26	
39	2	4	0.35	0.22	
40	2	4	0.50	0.25	
41	2	4	0.48	0.02	**
42	3	4	0.23	0.11	**
43	3	4	0.14	0.02	***
44	4	4	0.34	0.04	**
45	4	4	0.40	0.12	**
46	4	4	0.38	0.13	**
47	1	5	0.62	0.22	
48	1	5	0.77	0.21	
49	1	5	0.67	0.23	
50	1	5	0.51	0.29	
51	1	5	0.28	0.23	
52	2	5	0.57	0.20	
53	2	5	0.57	0.29	
54	2	5	0.54	0.25	
55	2	5	0.57	0.33	
56	2	5	0.59	0.27	
57	3	5	0.45	0.27	
58	3	5	0.72	0.27	
59	3	5	0.29	0.14	**
60	4	5	0.40	0.22	
61	4	5	0.56	0.18	
62	1	7	0.50	0.24	
63	1	7	0.63	0.18	
64	1	7	0.53	0.13	**
65	2	7	0.73	0.23	
66	2	7	0.67	0.24	
67	1	7	0.58	0.23	
68	2	7	0.40	0.11	**
69	3	7	0.55	0.23	
70	3	7	0.45	0.11	**
71	4	7	0.65	0.27	
72	1	1	0.62	0.28	
73	1	1	0.37	0.19	

*** Items <u>not</u> selected: outside range for DIFFICULITY and ITEM REL. INDEX #.

ITEM	GRID LOCATION ROW	COL.	DIFFICULTY	ITEM REL. INDEX #	ITEMS NOT SELECTED
74	1	1	0.51	0.19	
75	1	1	0.20	0.19	
76	2	1	0.74	0.24	
77	2	1	0.48	0.25	
78	3	1	0.14	0.14	***
79	1	3	0.59	0.24	
80	1	3	0.37	0.13	**
81	2	3	0.55	0.14	
82	3	3	0.62	0.22	
83	4	3	0.46	0.15	
84	2	2	0.95	0.11	***
85	2	2	0.85	0.18	*
86	2	2	0.69	0.23	
87	2	2	0.91	0.10	***
88	2	2	0.60	0.30	
89	2	2	0.59	0.23	
90	2	2	0.13	0.76	***
91	3	2	0.42	0.29	
92	3	2	0.33	0.12	**
93	4	2	0.04	0.07	***
94	3	2	0.53	0.16	
95	3	2	0.39	0.11	**
96	3	2	0.23	0.06	**
97	3	2	0.38	0.21	
98	1	4	0.95	0.08	***
99	1	5	0.51	0.21	
100	1	6	0.47	0.32	
101	1	9	0.14	0.05	***
102	1	1	0.71	0.25	
103	1	7	0.06	0.26	
104	1	8	0.52	0.31	**
105	1	3	0.53	0.33	**
106	1	9	0.52	0.29	

APPENDIX D

PROVINCIAL NORMS FOR

GRADE NINE SCIENCE EXAMINATION

SCORE	FREQ.	Z-SCORE	%-ILE	SCORE	FREQ.	Z-SCORE	%-ILE
0	0.0	-4.838	0.000	20	0.0	-2.655	0.004
1	0.0	-4.838	0.000	21	0.0	-2.655	0.004
2	1.0	-3.293	0.000	22	0.0	-2.655	0.004
3	0.0	-3.093	0.001	23	0.0	-2.655	0.004
4	0.0	-3.093	0.001	24	3.0	-2.546	0.005
5	0.0	-3.093	0.001	25	5.0	-2.349	0.009
6	0.0	-3.093	0.001	26	2.0	-2.229	0.013
7	0.0	-3.093	0.001	27	5.0	-2.135	0.016
8	0.0	-3.093	0.001	28	0.0	-2.078	0.019
9	0.0	-3.093	0.001	29	7.0	-2.008	0.022
10	0.0	-3.093	0.001	30	5.0	-1.907	0.028
11	0.0	-3.093	0.001	31	8.0	-1.815	0.035
12	0.0	-3.093	0.001	32	14.0	-1.689	0.046
13	0.0	-3.093	0.001	33	12.0	-1.567	0.059
14	0.0	-3.093	0.001	34	19.0	-1.447	0.074
15	0.0	-3.093	0.001	35	11.0	-1.348	0.089
16	1.0	-2.970	0.001	36	7.0	-1.294	0.098
17	1.0	-2.810	0.002	37	12.0	-1.241	0.107
18	0.0	-2.750	0.003	38	21.0	-1.157	0.124
19	1.0	-2.700	0.003	39	24.0	-1.054	0.146

SCORE	FREQ.	Z-SCORE	%-ILE	SCORE	FREQ.	Z-SCORE	%-ILE
40	20.0	-0.963	0.168	63	12.0	0.449	0.673
41	30.0	-0.868	0.193	64	16.0	0.487	0.687
42	16.0	-0.787	0.215	65	23.0	0.543	0.707
43	26.0	-0.718	0.236	66	29.0	0.620	0.732
44	27.0	-0.635	0.263	67	17.0	0.691	0.755
45	20.0	-0.565	0.286	68	21.0	0.752	0.774
46	22.0	-0.504	0.307	69	20.0	0.822	0.794
47	23.0	-0.442	0.329	70	18.0	0.890	0.813
48	18.0	-0.386	0.350	71	16.0	0.955	0.830
49	20.0	-0.336	0.368	72	9.0	1.005	0.843
50	30.0	-0.270	0.393	73	12.0	1.050	0.853
51	21.0	-0.205	0.419	74	11.0	1.101	0.864
52	28.0	-0.143	0.443	75	9.0	1.147	0.874
53	29.0	-0.072	0.471	76	15.0	1.207	0.886
54	23.0	-0.007	0.497	77	15.0	1.289	0.901
55	16.0	0.041	0.516	78	7.0	1.354	0.912
56	24.0	0.091	0.536	79	15.0	1.426	0.923
57	24.0	0.151	0.560	80	7.0	1.506	0.934
58	22.0	0.209	0.583	81	14.0	1.593	0.944
59	20.0	0.263	0.604	82	9.0	1.704	0.956
60	18.0	0.312	0.623	83	3.0	1.772	0.962
61	17.0	0.358	0.640	84	4.0	1.815	0.965
62	19.0	0.406	0.658	85	9.0	1.907	0.972

SCORE	FREQ.	Z-SCORE	%-ILE	SCORE	FREQ.	Z-SCORE	%-ILE
86	8.0	2.057	0.980	97	0.0	4.641	1.000
87	3.0	2.187	0.986	98	0.0	4.641	1.000
88	6.0	2.329	0.990	99	0.0	4.641	1.000
89	2.0	2.515	0.994	100	0.0	4.641	1.000
90	2.0	2.655	0.996	101	0.0	4.641	1.000
91	1.0	2.809	0.998	102	0.0	4.641	1.000
92	2.0	3.092	0.999	103	0.0	4.641	1.000
93	0.0	4.641	1.000	104	0.0	4.641	1.000
94	0.0	4.641	1.000	105	0.0	4.641	1.000
95	0.0	4.641	1.000	106	0.0	4.641	1.000
96	0.0	4.641	1.000				